

Construction Laborer Dies After Being Run Over and Crushed by a Grader at a Road Construction Site - North Carolina**SUMMARY**

On December 4, 2001, a 54-year-old male construction laborer (the victim) was fatally injured when he was run over and crushed by a motor grader (hereafter termed grader). At the time of the incident, the grader operator was driving the grader in reverse on a road under construction in a housing development. The victim and a coworker were standing in the road at the rear of their parked pickup truck discussing the next stage of their work when the grader operator began backing in their direction. The coworker saw the grader backing toward them and yelled to the operator to stop. The operator did not hear the warning. The back tire of the grader struck the victim, knocking him down. The operator stopped the grader when it struck the rear of the parked pickup truck. The victim was under the rear tire of the grader. The coworker told the operator to pull forward and then called 911 on his cell phone. Emergency medical services (EMS) and police personnel responded within minutes. Emergency care was initiated by EMS personnel and the victim was transported to an area hospital where he died approximately 90 minutes after the incident.

NIOSH investigators concluded that, to help prevent similar occurrences, employers should

*Vehicle struck by the grader***Fatality Assessment and Control Evaluation (FACE) Program**

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatality Assessment and Control Evaluation (FACE) investigations when notified by participating states (North Carolina, Pennsylvania, South Carolina, Tennessee, and Virginia); by the Wage and Hour Division, Department of Labor; or when a request for technical assistance is received from NIOSH-funded state-level FACE programs in Alaska, California, Iowa, Kentucky, Massachusetts, Minnesota, Nebraska, New Jersey, New York, Ohio, Oklahoma, Texas, Washington, West Virginia, and Wisconsin. The goal of FACE is to prevent fatal work injuries by studying the work environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact. FACE investigators evaluate information from multiple sources that may include: interviews of employers, workers, and other investigators; examination and measurement of the fatality site, and related equipment; and review of records such as OSHA, police, medical examiner reports, and employer safety procedures and training records. The FACE program does not seek to determine fault or place blame on companies or individual workers. Findings are summarized in narrative reports that include recommendations for preventing similar events in the future. For further information visit the FACE website at www.cdc.gov/niosh/face/faceweb.html or call toll free 1-800-35-NIOSH.



- *develop, implement, and enforce a comprehensive written safety program for all workers which includes training in hazard recognition and the avoidance of unsafe conditions*
- *conduct a prework safety meeting each day to discuss the work to be performed, potential safety hazards and safe work procedures, and means to be used for communicating changes to the work plan*
- *ensure that equipment is inspected daily and all defective equipment is removed from service until needed repairs have been made*
- *ensure that required personal protective equipment is provided and used in accordance with company policy*
- *consider installing strobe lights on company-owned pickup trucks used on road construction sites*

Additionally,

- *manufacturers of heavy equipment, such as graders, should explore the possibility of incorporating collision avoidance technology on their equipment.*

INTRODUCTION

On December 4, 2001, a 54-year-old male construction laborer (the victim) was fatally injured when he was run over and crushed by a grader that was being operated in reverse. On January 8, 2002, officials of the North Carolina Occupational Safety and Health Administration (NCOSHA) notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), of the incident. On March 5, 2002, a DSR occupational safety and health specialist met with both the NCOSHA compliance officer assigned to the case and his supervisor to discuss the case and to review information collected in the course of their investigation. On March 6, 2002, the employer and his newly appointed safety manager were interviewed. The grader operator and coworker were no longer working for the company and were not available for interview. Official reports from the police department and the coroner's office and photographs taken at the scene by NCOSHA and the City County Bureau of Investigation were reviewed.

The employer was a road construction contractor that had been in business for 7 years. The company employed 60 to 70 workers on various sites during the peak road-building season. The incident occurred on a road under construction in a housing development. The road was not yet open to public travel and had been under construction for 3 weeks. Nine workers were on site the day the incident occurred; four laborers (including the victim) performed general duties which included shoveling spilled gravel back onto the roadway and filling in low spots, two grader operators, two roller operators, and one excavator operator.



The employer had a general written safety program. Although the company had a safety policy requiring workers on foot to wear high-visibility vests while working on site, none were being used at the time of the incident. The victim had worked for the company for 6 months. New employees, including the victim, were provided basic 1- to 2-hour orientation to the job which primarily covered benefits, the type of clothing and shoes required, and the tasks workers were to perform. The company held two to three safety talks per year, but attendance was not mandatory. The victim had not attended any safety talks. According to the employer, the grader operator involved in the incident had worked for the company as a grader operator for 5 years and had learned to operate the grader through on-the-job training. This was the company's first workplace fatality.

Following this fatality, the company hired a full-time safety manager and developed a more comprehensive employee policies and safety handbook that included operating procedures to follow while operating or working around mobile equipment.

INVESTIGATION

Road work, which included cutting the road, installing curbs and gutters, graveling, and grading had been in progress for 3 weeks. The road was not open to public travel. On the day of the incident, the employer assigned two three-man crews to the site plus two additional laborers and one excavator operator. Each three-man crew was comprised of one grader operator, one roller operator, and one laborer. Workers arrived at the site at 7 a.m. During the morning, the grader operators spread gravel, the roller operators compacted the gravel, the excavator operator made back cuts where compaction was poor due to soil conditions, and the laborers hand shoveled gravel into low spots. The workers planned to stop for a lunch break at 2:30 p.m.

Shortly before 1:45 p.m. Grader Operator #1 asked the victim and his coworker to use the pickup truck to haul a tamper and drop it off along the roadway. At approximately 1:45 p.m., after picking up the tamper, the victim and a coworker drove a pickup truck around the work site to ask coworkers for food and drink requests. At approximately the same time, Grader Operator #1 was at the entrance to the development and was informed by the company owner that the company's water truck was on its way. He then drove his grader down to the location of grader #2 to inform Grader Operator #2 that the water truck was on its way (Figure 1 illustrates work-site layout). While Grader Operator #1 was talking with Grader Operator #2, the victim and coworker stopped their truck and asked Grader Operator #2 for his food order. Grader Operator #1 told NCOSHA investigators he saw the victim and his coworker leave in their work truck. After Grader Operator #1 finished his conversation with Grader Operator #2, Grader Operator #2 drove his grader down a slope and around a curve to the east where he resumed his work. Grader Operator #1 began to back his grader uphill and northwest toward the entrance to the development. No information was available regarding the grader's speed at the time of the incident. Based on the grader manufacturer's brochure for the make and model used on the day of the incident, the grader had six reverse gears that ranged in speed from 1.8 miles per hour to 20.9 miles per hour. In the meantime, the victim and his coworker parked the pickup truck alongside the curb on the right side of the roadway to drop off the tamper. They were approximately 400 feet from the location where Grader Operators #1 and #2 had been talking. The pickup truck was parked facing west toward the entrance to the development. The victim and his coworker left the truck running and unloaded the tamper and placed it along the curb on



the passenger side of the truck. The coworker was facing toward the entrance and was checking the oil and gas levels in the tamper and was starting to tell the victim to go to the entrance to help other crew members when the incident occurred. Photo 1 illustrates the approximate location of the victim and coworker. The victim was standing at the rear of the truck on the driver's side facing the back of the truck, and the coworker was standing approximately 2 feet from the victim nearer the curb. Neither worker was wearing a high-visibility safety vest. The coworker looked up and saw the grader coming toward them. He yelled for the grader operator to stop. Grader Operator #1 did not hear the warning, and the back tire of the grader struck the victim in the upper back and knocked him to the ground. Grader #1 continued moving in reverse, striking the bumper and tailgate of the pickup truck (Photo 1). The operator stopped after the impact. The left rear tire of the grader had rolled on the victim's upper back and head. The coworker ran to the operator and told him to pull forward to free the victim. The coworker then used his cell phone to call 911. Emergency medical services (EMS) and police personnel received the call at 2:07 p.m. and responded within minutes. The victim had sustained major traumatic injuries to the face and torso. Emergency care was initiated by EMS personnel and the victim was transported to an area hospital where he was pronounced dead at 3:32 p.m.

NCOSHA investigators examined road grader #1 (the grader directly involved in the incident). The road grader was manufactured in 1996. According to the construction company owner, he had leased the grader when it was new under a long-term lease from an equipment rental company. He had used the grader for approximately 5 years and had a verbal agreement with the rental company that his company would take responsibility for all minor repairs and servicing which included maintaining or replacing backup alarms. The grader was equipped with a backup alarm (Photo 2). When the backup alarm was tested by NCOSHA and police department investigators on the day of the incident, the alarm emitted no audible signal.

The victim's coworker told NCOSHA investigators that he did not hear any warning sounds coming from the grader. Evidence indicates that several pieces of equipment were running near the location of the incident: the pickup truck, grader #1, and a roller, approximately 400 feet away (see Figure for work-site layout).

Grader Operator #1 told NCOSHA investigators that he had notified his superiors that the backup alarm was not working properly 2 weeks before the incident, but it had not been replaced. The grader operator told police and NCOSHA investigators that he did not see the workers or their parked pickup truck because the sun was shining in his eyes. Police investigators determined that visibility was nearly impossible when seated in the driver's seat of the grader and looking backward due to the bright setting sun and the dust- and dirt-covered cab windows and mirrors (Photo 3). NCOSHA investigators inspected side mirrors that had been installed on each side of the grader by the equipment lender; they were loose and would not stay in place when adjusted.

Grader Operator #2 told NCOSHA investigators that because he was working to the east and at the bottom of a hill in a curved section of the road, he did not see any of the events leading up to the fatal incident.



CAUSE OF DEATH

The coroner's report indicated that the cause of death was blunt-force trauma.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop, implement, and enforce a comprehensive written safety program for all workers which includes training in hazard recognition and the avoidance of unsafe conditions.

Discussion: Given the known hazards associated with road construction (e.g., hazards of being struck by or run over by vehicles and/or equipment), employers should provide their workers with a comprehensive safety program and training that addresses standard operating procedures that are to be followed when working on or near moving vehicles and /or equipment. Safe equipment operation around workers on foot, for example, should include isolating workers on foot from equipment as much as possible, scheduling work tasks to keep workers on foot out of areas where heavy equipment is used, and training workers on foot and equipment operators in appropriate communication methods (e.g., two-way radio, personal one-on-one, hand signals, etc.) that are to be used.

Because all workers, including equipment operators and supervisors, are likely to be on foot around operating equipment, all workers should be trained to recognize the hazards of working on foot around equipment. Training should be a vital part of a road construction company's safety program and should address, at a minimum, all known and anticipated hazards. OSHA regulations require employers to train workers to recognize and avoid unsafe conditions that may be present in their work environments (e.g., 29 CFR 1926.21(b)(2).¹ Equipment operators should be trained to operate equipment in accordance with safety rules found in the equipment operator's manual and with safety rules written by the company. They should be trained to never move equipment without first inspecting the area around them and making positive visual contact with any workers on foot near the equipment. If equipment operators cannot see behind them as they back up, they should be trained to stop their machines, dismount, visually examine the area behind their machine and to clear the area of workers and equipment before proceeding. Employers should ensure that equipment operators are trained to examine the cab glass and mirrors on equipment they are using and to clean cab glass and mirrors and adjust their mirrors as needed prior to equipment use. Employers can obtain additional information pertaining to preventing injuries from vehicles and equipment in work zones in a NIOSH document on this topic (DHHS, NIOSH Publication No. 2001-128).²

Note: Following the incident the company developed an expanded employee policies and safety handbook and distributed it to all workers. The heavy equipment section in the handbook provides a general statement regarding heavy equipment users/use and defines in detail all required procedures for "start-up," "operation" and "shut down." A copy of the heavy equipment procedures is to be kept in all vehicles. Several of the general policy statements address specific issues related to this fatality and include "DO NOT operate any vehicle unless everything is satisfactory. Report any problems to your supervisor immediately and wait for his instruction. Always be aware of your position in relation to other vehicles, equipment, stationary objects, and workers on foot." The handbook provides detailed procedures that are to be followed before operating machines, as follows:

*“Clear all personnel from the machine and the area.
Remove all obstacles from the path of the machine.
Be aware of hazards such as wires and ditches.
Be sure that all windows are clean.
Secure the doors and secure the windows in either the open or closed position.
Adjust the rear view mirrors. Adjust the side mirrors. Make sure that the machine horn, the
backup alarm, and all other warning devices are working properly.
Fasten the seat belt securely.”*

Recommendation #2: Employers should conduct a prework safety meeting each day to discuss the work to be performed, potential safety hazards and safe work procedures, and means to be used for communicating changes to the work plan.

While a company's comprehensive written safety program and its safety training program provide an overall framework for worker safety on road construction sites, daily prework meetings are needed to discuss the work scheduled for the day and to discuss potential hazards that may arise. When there is a change in the work plan during the day's work, the supervisor assigned to the site should inform all workers of the changed plan and discuss how to safely carry out the assigned work. Workers should be informed about the methods that are to be used to communicate changes in the work plan, such as through the use of personal one-on-one communication or through the use of two-way radios. For example, if all workers on site had been informed of the decision to haul and drop off a tamper along a section of road where graders and rollers were operating, all workers could have been instructed to remain out of that area until the drop-off was completed and until they were notified that the area was clear.

Additionally, a prework plan and person-to-person communication may have resulted in the identification of a safer location for parking the pickup truck during the tamper drop-off, a location that was out of the path used by heavy equipment.

Employers should consider equipping their workers with two-way radios and training them in their appropriate use. Use of properly functioning two-way radios by workers trained to use them has the potential for greatly improving communication and consequently safety.

Recommendation #3: Employers should ensure that equipment is inspected daily and all defective equipment is removed from service until needed repairs have been made.

Discussion: Employers should designate a supervisor to be responsible for daily preshift equipment checks and for verifying that any problems are corrected. Although equipment may also be inspected by other workers, for example the equipment operator, the supervisor must be responsible for ensuring that inspections are performed daily, that necessary repairs are made, that scheduled maintenance is performed, and that records of all inspections are maintained. Equipment should be removed from service until repairs are made. For example, equipment should be removed from service until a malfunctioning backup alarm is replaced with a functioning audible alarm. According to OSHA standards, earthmoving equipment which has an obstructed view to the rear can be used in reverse gear only when the equipment has in operation a



reverse signal alarm distinguishable from the surrounding noise level or when there is an employee available to signal the equipment operator that it is safe to move in reverse (29 CFR 1926.602 (a)(9)(ii).³

Additionally, all mirrors should be inspected daily to ensure that they are attached and maintained in a manner that allows them to be adjusted by the operator.

Recommendation #4: Employers should ensure that required personal protective equipment is provided and used in accordance with company policy.

Discussion: Employers should develop a company policy that requires that all employees be supplied with appropriate personal protective equipment and trained in its use. They should then enforce the policy. After this incident occurred, the employer hired a full-time safety manager who has been charged with providing safety training and with ensuring that personal protective equipment, such as a high-visibility vest and appropriate eye protection now required by company policy, is provided and used.

Recommendation #5: Employers should consider installing strobe lights on company-owned pickup trucks used on road construction sites.

Discussion: Dusty conditions on road construction sites can decrease visibility. Equipping pickup trucks used around operating equipment with strobe lights would make the trucks more visible to heavy-equipment operators and to workers on foot.

Recommendation #6: Manufacturers of heavy equipment, such as graders, should explore the possibility of incorporating collision avoidance technology on their equipment.

Discussion: Equipment manufacturers should evaluate research currently being conducted on navigation and warning aids for mobile equipment in the mining industry and utilize this information to develop collision warning systems for construction equipment. One promising technology for this application uses radio frequency identification (RFID) tags and tag readers. Each worker on foot wears a small RFID tag. A tag reader is mounted on each piece of mobile equipment. When a tag is sensed within the tag reader's sensing range, the equipment operator receives a warning. Manufacturers can obtain additional information pertaining to research on navigation and warning aids for mobile equipment in NIOSH documents (DHHS, (NIOSH) Publications 98-114, 2001-128, and RI9652).^{4,2,5}

REFERENCES

1. Code of Federal Regulations 2001 edition. 29 CFR 1926.21 (b)(2). Safety training and education. U.S. Printing Office, Office of Federal Register, Washington D.C.
2. NIOSH [2002]. Building safer highway work zones: measures to prevent worker injuries from vehicles and equipment. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2001-128.



3. Code of Federal Regulations 2001 edition. 29 CFR 1926.602 (a)(9)(ii). U.S. Printing Office, Office of Federal Register, Washington D.C.
4. NIOSH [1998]. Program for mining research, navigation and warning aides for mobile equipment, pg 20. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 98-114.
5. NIOSH website: <http://www.cdc.gov/niosh/pdfs/ri9652.pdf>. NIOSH [2000]. Test results of collision warning systems for surface mining dump trucks. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) RI 9652.

INVESTIGATOR INFORMATION

This investigation was conducted by Doloris N. Higgins, Occupational Safety and Health Specialist, Fatality Assessment and Control Evaluation Team, Surveillance and Field Investigations Branch, Division of Safety Research.



Photo 1: This photo illustrates the approximate location of the victim (V) and the coworker (CW) at the time of the incident. The tailgate of the truck shows damage that resulted when the grader struck the truck.

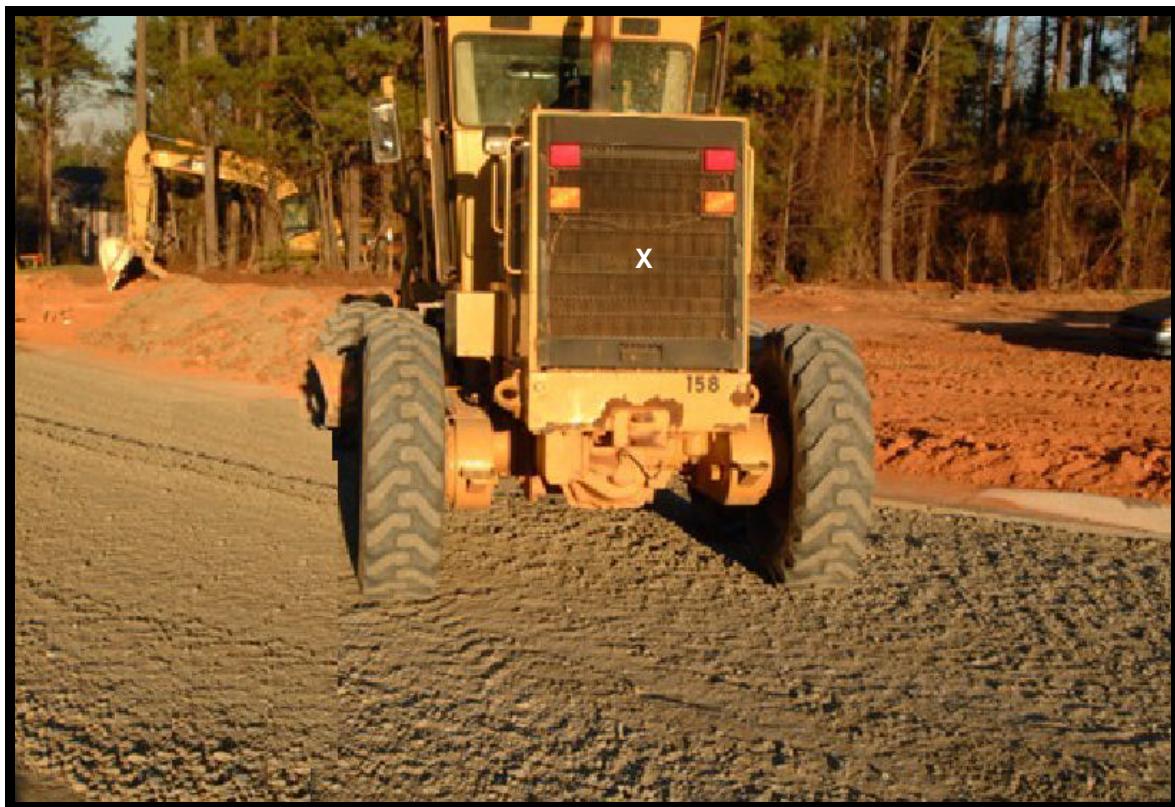


Photo 2. This photo illustrates the rear of the grader used at the time of the incident. The backup alarm is positioned behind the grill work and is marked with an X.



Photo 3: This photo illustrates the view through the back window from the driver's seat of the grader. Some of the dust was rubbed off, and upon careful scrutiny through the haze, one can barely see a person standing several feet behind the grader.

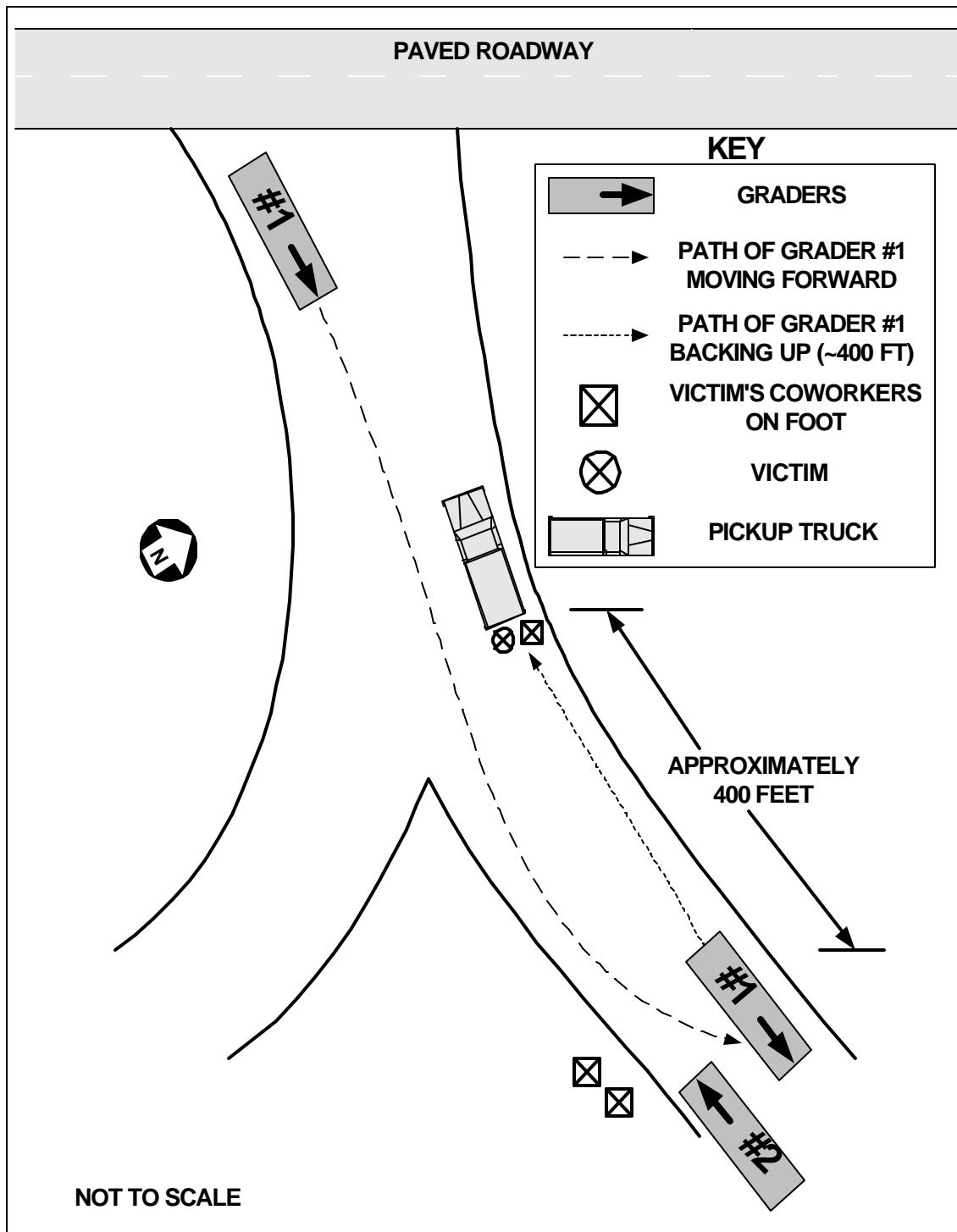


Figure 1: Figure Illustrates Residential Roadway Schematic.